MERAC Prize in Theoretical Astrophysics :Magnetism in stellar systems (No 2121)

01.07.2021 14:00 - 14:30 Prize winner
Thursday Plenary

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The magnetic field of solar-like, cool stars shapes their corona and astrosphere and can lead to intriguing magnetic interactions with close-in planets. Such stellar magnetic field are sustained by dynamo processes operating in their internal turbulent convective regions. They are generally observed to be variable in time, as it is the case for the Sun with its mysterious magnetic cycle of 11 years, and their properties vary over secular timescales. A dynamical dynamo field naturally triggers a dynamical corona. Close-in exoplanets around magnetic stars are thus likely to be subject to a strongly varying magnetic interactions, which can lead to potentially observable emissions, planetary evaporation, or even planet migration due to magnetic torques.

I will present a series of work tackling the various aspects of the magnetism of a star and its environnement, based on massively parallel numerical simulations using various magnetohydrodynamics formulations. I will first give a brief tour of our understanding of the origin of the cyclicality of solar-like magnetic fields, within the context of both astrophysical fluid dynamics and stellar evolution. Then, I will present state-of-the-art 3D numerical simulations of stellar winds capable of using observed (or modelled) complex and time-varying magnetic topologies. I will finally explore the implication of stellar magnetism on close-in planets using global 3D models of star-planet systems. I will lay out the basic principles behind magnetic star-planet interactions, which ressemble planet-satellite interactions. I will conclude with our most recent numerical efforts to model these interactions, and the following perspectives to constrain the hypothetical magnetic field of close-in exoplanets.